Space Weather Technical Forecast

Issued on Monday, 13 November 2023 at 13:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1/Minor Storms on Day 1 (13 Nov) due to coronal hole. Chance of M-class flares, declining through the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low with only C-class flares in the last 24 hours. There are currently six sunspot regions on the disc. AR3483 in the northwest remains the largest region, perhaps with some minor magnetic complexity, however this is getting more difficult to assess as it starts to approach the limb. AR3486 in the south-centre disc appears to have stabilised. A NEW region has appeared in the southwest. The other regions appear relatively stable in recent hours, although as with all regions approaching the west limb the analysis becomes more difficult, and for those closest to the limb their classification will be maintained as they rotate off the disc.

Solar Wind / Geomagnetic Activity:
Solar winds, as observed at L1 by ACE and DSCOVR, have been easing through the past 24 hours, initially being Elevated at 540km/s after a CME arrival around 12/0530 but have now eased to ambient to slightly elevated levels at 400km/s. Density has been above average, peaking at 38pccc. The total magnetic field strength (Bt) has been on average moderate but has recently fallen too weak as the Earth left the magnetic cloud of the CME. The north-south component (Bz) was moderately positive, before rotating negative just after 12/2200, becoming positive again from 12/0200 before recently becoming mainly positive again. The phi angle was initially negative (toward away from Earth) before becoming positive (away From Earth). Geomagnetic activity was Quiet to Unsettled (Kp 1-3), but with a G1 minor storm (Kp5) at 250000/2503000.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at background levels. GOES16 high energy (greater than 2MeV) electron flux was initially at high levels, peaking at 2440pfu at 12/1355 UTC, but declined to moderate levels after 12/1830 UTC, and dropped to background levels from 13/0000. The associated 24-hour fluence was above the Active (1e8 integrated pfu) threshold initially but has been on a declining trend. The fluence observation at 13/1200UTC was 5.5e7 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Four of the six sunspot regions currently on the disc are due to rotate off in the coming days. There is a gradually declining chance of M-flares occurring through the period, becoming a slight chance by Day 3 (15 Nov).

Solar Wind / Geomagnetic Activity: A faint and slow CME was observed leaving the Sun late on 10 Nov. There is a chance of a glancing blow on Day 3 (15 Nov) but with very limited impacts expected. Current wind speeds are approaching background ambient levels, effects from CH68/+ may cause slightly elevated wind speeds at times Day 1 and perhaps into Day 2 (13 and 14 Nov).
Overall, geomagnetic activity may be Unsettled to Active with a chance of isolated G1/Minor

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Storm intervals at first from any interaction from CH68/+. This gradually easing through Day 2 (13 Nov) to be Quiet to Unsettled for much of the rest of the period. Active intervals are possible on Day 3 should we see a glancing CME arrival.

Energetic Particles / Solar Radiation: There is a slight chance of S1 or greater radiation storm conditions should any of the western hemisphere sunspot groups produce significant flares during the period. This risk will wane through the period as these sunspots rotate well away from the western limb.

The electron flux is now currently at background levels. There is low confidence in the behavior of the electron flux in the coming days, but it is possible we may see an increase in the electron fluence again over the coming days, along with the decline in geomagnetic activity.

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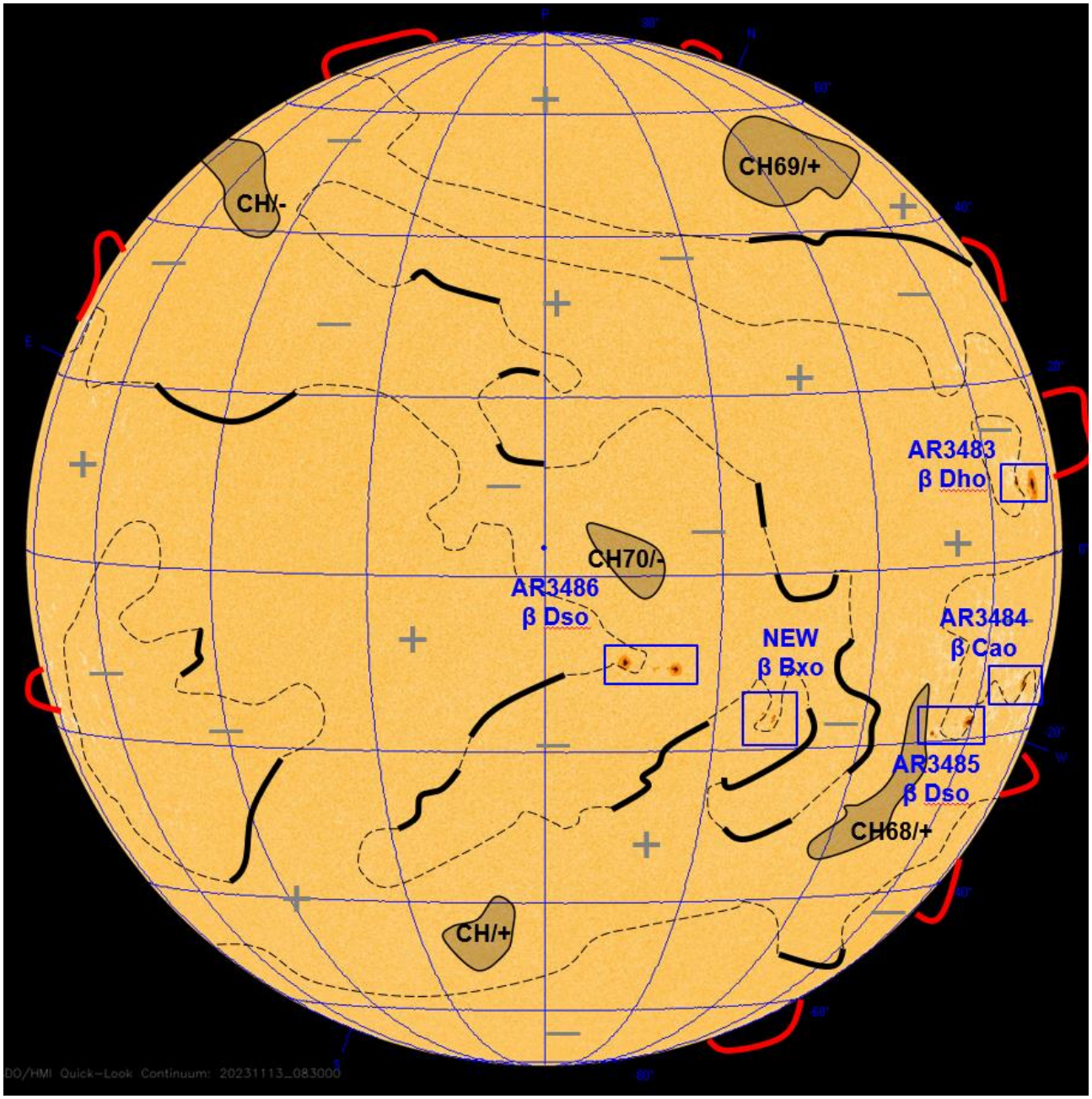
Figure 1. Solar Analysis Valid 0800.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The full halo CME which left the Sun on 09 Nov arrived at Earth at 12/0530UTC. Initially impacts were fairly muted due to the northward directed magnetic field, but a minor magnetic storm (G1/Kp5) occurred from 13/0000UTC-13/03000UTC due to a switch to the southward directed field.
A faint and slow CME was observed leaving the Sun late on 10 Nov. The source region of this CME appears to be an eruption in the southwest quadrant in the vicinity of the trio of sunspots (AR3477, AR3484 and AR3485). Modelling suggests that the bulk of the CME will miss ahead of Earth's orbit, however there is a chance of a glancing blow on Day 3 (15 Nov) but with very limited impacts expected.
Current wind speeds are approaching background ambient levels, effects from CH68/+ may cause slightly elevated wind speeds at times Day 1 and perhaps into Day 2 (13 and 14 Nov). A further very small feature, CH70/-, is unlikely to give significant impacts at Earth, but may cause a slight enhancement to solar winds on day 3, perhaps alongside the glancing CME.
Overall, geomagnetic activity may be Unsettled to Active with a chance of isolated G1/Minor Storm intervals at first from any interaction from CH68/+. This gradually easing through Day 2 (13 Nov) to be Quiet to Unsettled for much of the rest of the period. Active intervals are possible on Day 3 should we see a glancing CME arrival.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	25	10	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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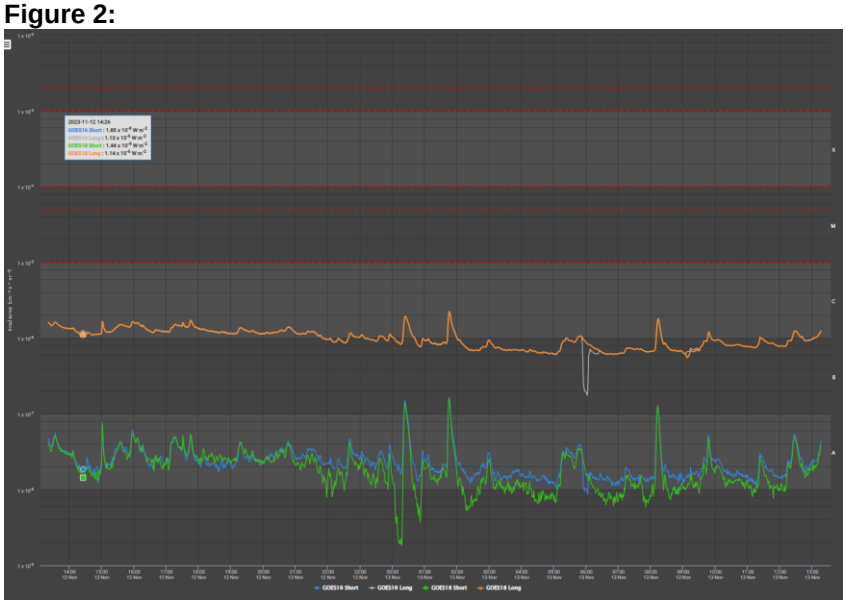
Radio Blackouts - X-Ray Flares:

There are currently six sunspot regions on the disc. AR3483 (Dho/Beta) in the northwest remains the largest region, perhaps with some minor magnetic complexity, however this is getting more difficult to assess as it starts to approach the limb. AR3486 (Dso/Beta) in the south-centre disc grew rapidly for a time overnight, although this growth now seems to have stabilised. A NEW region has appeared in the southwest. The other regions appear relatively stable in recent hours - but as with all regions approaching the west limb the analysis becomes more difficult, and for those closest to the limb their classification will be maintained as they rotate off the disc.
In terms of the risk from the current visible sunspot regions, AR3477 should depart later on Day 1 (13 Nov), followed by AR3483 and AR3484 late on Day 2 (14 Nov) and AR3485 late on Day 3 (15 Nov). This should significantly reduce the risk of M-class flares, although further sunspot development is possible at any time. Far-sided soundings, persistence and flux looping all suggest limited contributions from any returning regions over the eastern limb during the period. All this taken into account, there is a gradually declining chance of M-flares occurring through the period, becoming a slight chance by Day 4 (16 Nov).

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	20	15
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 2:



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is at background levels. There is considered to be a slight chance of S1 or greater radiation storm conditions during the period, owing to the various sunspot regions currently located in the western hemisphere. Probabilities then begin to wane later in the period as these regions rotate well away from the west limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has been at High levels over recent days in response to the fast wind from CH67/-. The electron flux dropout, associated with the 09 Nov CME which arrived around 12/0530 UTC, was observed after midnight and the electron flux is now currently at background levels. There is low confidence in the behaviour of the electron flux in the coming days, but it is possible we may see an increase in the electron flux again over the coming days, along with the decline in geomagnetic activity.
Electron fluence is currently declining but has a risk of increasing again day 2 onwards in response to the increased electron flux, but with low confidence in the timing, this will bring a chance of active fluence later in the period. However, MOSWOC REFM is suggesting active fluence may occur through the next three days - this is perhaps an overestimate, however there is a chance of reaching active.

GEO Electron Environment	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^{8}$	Yes	100	40	50	50
Very Active	≥ 2 MeV ≥ $1x10^{9}$	No	1	1	1	1

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